PREVALENT FALLACIES CONCERNING SUBACROMIAL BURSITIS. ITS PATHOGENESIS AND RATIONAL OPERATIVE TREATMENT.

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Since the publication of Codman's[1] classic description of subacromial bursitis as "the common cause" of shoulder disability ("stiff and painful shoulder"), various articles on the subject have appeared in journals and text-books. It is curious to note in almost all of these, and in the conceptions of the condition held by surgeons and roentgenologists generally, here and abroad, that gross fallacies prevail—despite the precise observations of Codman as to some of them, and in the evident absence of critical study concerning all of them.

These fallacies are:

1. That thickening of the bursal walls casts a shadow in the roentgenogram.
2. That the calcareous deposit found in many of the cases is *in* the bursa.
3. That subacromial bursitis often arises from vaguely conceived bacterial or "toxic" irritation.
4. That subacromial bursitis is marked by decided swelling in the deltoid region.
5. That there is a characteristic point of tenderness over the outer aspect of the shoulder just below the acromion margin, and that the absence of this sign indicates, clinically, absence of bursitis.
6. That the routine operative treatment to be recommended is "excision of the entire bursa."

Based on a personal study of over one hundred cases of shoulder disability, including nineteen that showed this calcareous deposit radiographically, seven of which I operated upon, this communication is written to correct these fallacies.

1. The Roentgen-ray Shadow. As may be demonstrated by radiographs after operation (*vide infra*) a much thickened bursal wall casts no shadow, and with the removal of the calcareous deposit the shadow disappears.

2. The Calcareous Deposit. This is *not in* but entirely *beneath* the bursa, in or in and upon the supraspinatus tendon or,

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[1] On Stiff and Painful Shoulders; The Anatomy of the Subdeltoid or Subacromial Bursa and its Clinical Importance; Subdeltoid Bursitis, Boston Med. and Surg. Jour., 1906, cliv, 613. Bursitis Subacromialis or Periarthritis of the Shoulder-joint (Subdeltoid Bursitis), Boston Med. and Surg. Jour., beginning October 22, 1908, clix. "Stiff and Painful Shoulders" as Explained by Subacromial Bursitis and Partial Rupture of the Tendon of the Supraspinatus, Boston Med. and Surg. Jour., 1911, clxv, 115.

occasionally, the infraspinatus near its insertion. To be sure Painter,[2] who was the first to record the calcareous formation in subacromial bursitis, reported four cases with shadows in the radiographs, in two of which, he says, the bursa contained lime-bearing, cheesy material. But in the other two he found no deposit in the bursa, did not look beneath it, and assumed that the shadow was produced by the thickened bursal wall, which he excised—an assumption which he failed to control by a subsequent radiograph. Codman was present at one of Painter's operations, and noted in his own article[3] that the calcareous material seemed to him to have come from beneath the bursa. He reported[4] three cases operated upon by himself, in all of which the deposit lay just beneath the floor of the bursa. It is not difficult for one who has performed the operation to understand why Painter made this faulty observation. If the dissection is not made with this point in mind it is easy, especially in adherent cases, to inadvertently cut into the floor of the bursa with the same incision that divides its roof, thus allowing the often cheesy deposit beneath to flow out apparently from within the bursa.

My series of seven operations amply corroborates Codman's finding and the observation, in a single case, of Wrede.[5] In three of my cases the deposit lay on the supraspinatus tendon and underneath the bursal floor. In one case it was completely imbedded in the *infraspinatus* tendon near its insertion in the tuberosity. In three cases it was entirely concealed in the supraspinatus tendon—one (semifluid) near, and two at a considerable distance from its insertion. In three of these cases of intratendinous deposit and in one of extratendinous location (Fig. 3), the material was dry, gritty, and composed of rough, sand-like granules, in color and appearance much resembling shad roe or yellow tartar when scraped from the teeth. Here and there in the mass may sometimes be found slightly larger, smooth bodies resembling miniature sesamoid bones. An analysis of all these tiny bodies from one case, made by Dr. S. Bookman, physiological chemist to Mount Sinai Hospital, showed them to be composed "chiefly of calcium oxalate, with smaller amounts of calcium carbonate, magnesium carbonate, blood fibrin, and serum albumin." The calcium salts vary, however, in their presence and proportions.

In the other three cases, one acute (16 days) and two chronic (several months), the deposit was semifluid—small and whitish in two cases, large and yellowish in one case. These are the accumulations that Codman quite pictorially describes as "wenlike." He is wrong, however, in referring to them as cysts and in speaking of their sac. They are not cysts, and in neither the extra- nor the intratendinous variety has the deposit any sac or limiting membrane. The semifluid material from a case of four months' duration, examined by Dr. Celler, associate in pathology to Mount Sinai Hospital, was found microscopically to consist of "broken-down cellular material, many fat cells, a small amount of lime; no leukocytes; no tubercle bacilli or other bacteria in spreads; cultures sterile after seventy-two hours; guinea-pig inoculation, negative." Baer[6] stated, however, that "if the process is a tuberculous one the cavity may be filled with a dense, cheesy material," which we know now to be an error, as well as is his statement that "when the bursa is replaced by dense scar tissue there is a shadow to be seen in the radiographs." When yellow and quite fluid, the material is easily mistaken for pus, as by Cumston.[7]

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[2] Subdeltoid Bursitis, Boston Med. and Surg. Jour., 1907, clvi, 345.

[3] Codman, loc. cit., second article.

[4] Codman, loc. cit., second and third articles.

[5] Ueber Kalkablagerung in der Umgebung des Schultergelenks und ihre Beziehungen zur Periarthritis scapulo-humeralis, Arch. f. klin. Chir., 1912, xcix, 259.

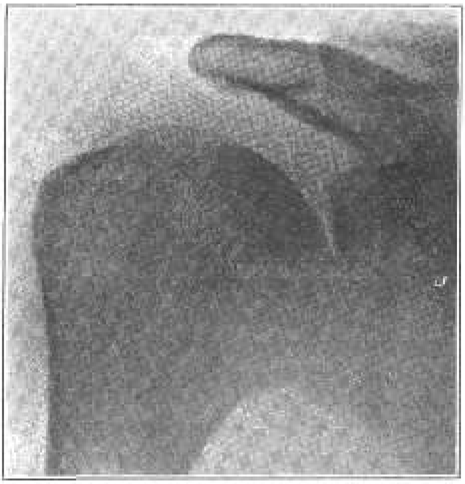

FIG. 1.—Linseed-sized shadow in a case of semifluid extratendinous deposit as large as a finger-nail.

The roentgen-ray appearances of these deposits vary. The shadow is usually close to or even in contact with that of the greater tuberosity of the humerus, but it may be at some distance from the tuberosity in the line of the supraspinatus, or separated by a wide space from the bone margin. The shadow may be very small (Fig. 1) or quite large (Fig. 2, from a case in which the calcareous material removed would thickly cover a fifty-cent piece). Usually single, the deposit is sometimes multiple (Fig. 3). The dry deposits correspond in size with their shadows. The fluid deposits, containing but a relatively small amount of lime, are much larger than their shadows. Thus in the case of which Fig. 1 is the radiograph the deposit was the size of a finger-nail.

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[6] Operative Treatment of Subdeltoid Bursitis, Bull. Johns Hopkins Hospital, June, July, 1907, p. 282.

[7] Acute Suppurating Bursitis of the Subdeltoid Bursa, Annals of Surgery, 1913, lvii, 143.

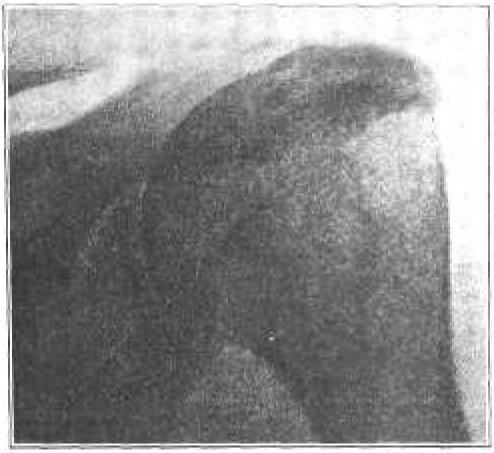

FIG. 2.—Unusually large, cap-like, dry extratendinous deposit.

Nor is the lime formation a slow or late process. In the acute case referred to its presence was revealed by the radiograph ten days after the undoubted trauma that originated the symptoms (lurch of the body while hanging to a street-car strap), and it was demonstrated at the operation six days later. In another acute

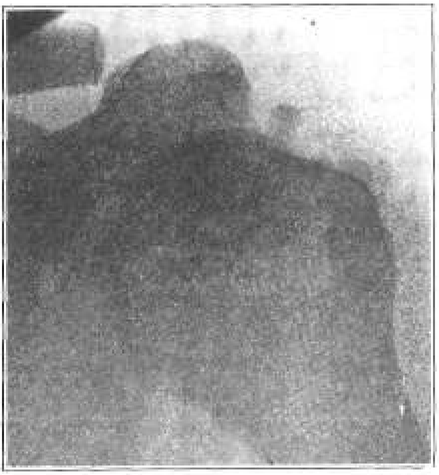

FIG. 3.—Multiple calcareous deposits.

case two large shadows were shown by the roentgenogram eleven days after a fall on (?) the shoulder, and these two dry calcareous deposits were removed from within the supraspinatus tendon on the seventeenth day after the injury. In another case a deposit was found by the roentgen rays on the fifth day after trauma.

In none of my cases (all, however, operated upon within a year and a half after the onset) was there any infiltrating calcification of the tendon, or ossification. The deposit occurs in a discrete mass or masses, readily removable with a blunt spoon.

In all three cases of extratendinous deposit I found a small transverse tear in the supraspinatus near its insertion, such as Codman[8] so clearly describes, without deposit, as associated with the bursitis. The rupture was of variable depth, in one case extending through the thickness of the tendon and exposing the joint capsule. Within the rent lay more of the deposit. In one of these, an acute case, both the infra- and the supraspinatus tendons were swollen and deeply hemorrhagic. In the four cases in which the mass of lime salts was concealed within it, the surface of the tendon appeared normal.

As a result of contusion or tear of the tendon, there is a formation of granulation tissue, necrosis of tendon substance and deposition of lime. This corresponds with the histologic findings, to be published, in sections made from tendon fragments of my cases by Dr. E. Moschcowitz, pathologist to Beth Israel Hospital, New York. The deposition of lime in necrosed and inert tissues is a common phenomenon in pathology, *e. g.*, in tuberculous processes, scars, corpora Albicantia, etc. But its frequent, early, sometimes multiple appearance in the spinatus tendons after mild traumata has no parallel, as far as I know, in the human body. Its unique features present several interesting problems in the pathology of tendon injuries and of lime formation, the elucidation of some of which I hope to publish later.

3. THE ETIOLOGY. The condition is one of adult life. The assumption of a bacterial or toxic origin for subacromial bursitis has never been substantiated by any evidence. If such an etiology were common, we ought to find a similar affection in the olecranon, trochanteric, quadriceps, and other bursæ.

Excluding the rare tuberculous form described by Bilhaut[9] (of which I have seen but a single instance), and the purulent type, occasionally occurring metastatically in septic processes (of which I have operated upon three cases), I believe that subacromial bursitis is of traumatic origin, and that it is produced by bruising the structure between the acromion and the greater tuberosity (over which latter the adhesions and the thickening of the bursal wall are most often found). When, as is frequently the case, the underlying tendon is likewise contused or torn, the lime salts deposit in the area of necrosis that develops in this poorly vascularized tissue. Compression of the bursa and tendon between tuberosity and acromion is easily demonstrable at operation by abducting the arm.

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[8] Loc. cit., second article.

[9] Observations de Kyste à Grains Riziformes de la Bourse Sereuse Sous-deltoidienne, Ann. d'Orthop. et de Chir. prat., 1892, cxciii, 6.

To be sure, a history of injury is often obtained with difficulty and sometimes not at all. This is because the trauma is usually a comparatively mild form of internal violence, such as hanging from a car-strap or flying ring, throwing the weight of the body on the outstretched arm while scrubbing the floor, or forcibly abducting the arm to throw a ball or to strike at an object with a stick. Such common movements are often not associated by the patient with his developing shoulder disability, not only because they *are* so commonly performed but also because the pain, and especially the stiffness, may not seriously attract his attention for a few days thereafter. But we must not depend entirely upon careful anamneses of these cases for evidence that such forms of internal violence can seriously injure the bursa and the tendon. Codman[10] has reported two cases he operated upon of complete rupture of the supraspinatus tendon and tear of the bursal floor, produced, respectively, by throwing a heavy blanket over a clothesline, and by tightening a saddle-girth. In both cases something was felt to snap in the shoulder, and the arm fell limp.

Another, still milder form of internal violence has been described as causative of subacromial bursitis, and I have a few probable instances in my own series. This consists in repeatedly performed occupational movements, such as cello-playing, hammering, and machine operating. I am not at all sure, however, that in these cases the real cause was not some unduly forcible abduction movement.

Two types of external violence are also productive of subacromial bursitis. One of these is a fall upon the outstretched arm, which, it would seem, jams the head of the humerus against the acromion process, bruising bursa and tendon. The other is a fall or blow on the deltoid region. This latter injury may cause an irritation of the subdeltoid portion of the bursa, but it seems to me it is not very apt to tear the supraspinatus tendon. It may and often does, however, cause a tearing out of a portion of the supraspinatus insertion, *i. e.*, a small fracture of the greater tuberosity; and this condition closely simulates, clinically and radiographically, bursitis with calcareous deposit.

4. CONCERNING SWELLING. In the early stage there is probably always an effusion of serum into the bursa (Flint[11] aspirated 3

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[10] Complete Rupture of the Supraspinatus Tendon; Operative Treatment with Report of Two Successful Cases, Boston Med. and Surg. Jour., 1911, clxiv, 708.

[11] Acute Traumatic Subdeltoid Bursitis, a New and Simple Treatment, Jour. Amer. Med. Assoc., 1913, lx, 1224.

to 4 c.cm. in two acute cases); and *sometimes* this is sufficient in amount to produce an appreciable swelling in the deltoid region. In the later stage (and it is very often after several weeks or months that the patient first seeks relief) there is, in my experience, no swelling whatever. On the contrary, there may be a decided flattening of the deltoid from atrophy of that muscle, with which there may also be atrophy of the spinati. The electrical reactions remain normal, however.

5. POINT OF TENDERNESS; DIAGNOSIS. In easily recognized cases there is, indeed, localized tenderness over the outer aspect of the shoulder just below the acromion. But most instances of subacromial bursitis, in my experience, are not "typical," and I have found this sign as often absent as present. It is absent sometimes even in acute cases. Nor is the sign pathognomonic. It may be one of several points of tenderness in some other form of shoulder disability, or even when this is the only tender spot, it may be a manifestation of a fracture of the tuberosity, an inflammatory process in the bone or periosteum (tuberculosis, syphilis), etc.

The site of tenderness I find most constant in subacromial bursitis is anteriorly, *over the lesser tuberosity*, or a little above it; but this, too, is not pathognomonic. Sometimes the only, or the greatest tenderness is posteriorly, over the line of the infraspinatus. In some cases of long duration there is no point of noteworthy tenderness.

Dawbarn's sign—disappearance of the typical point of tenderness when the bursa is carried under the acromion by abducting the arm —I find only occasionally positive. This tenderness, when it is present, very often does not thus disappear.

A sign I described[12]—pain referred to the outer deltoid region on gently pressing the circumflex nerve against the inner aspect of the humerus—is also only occasionally present. Greater or less limitation of abduction and of internal rotation is a striking feature of the typical cases. But I have found dense adhesions in the bursa of two who could abduct and rotate the arm fully, although with some effort. I have radiographs, too, showing large calcareous deposits in patients who complained only of annoying pains in the shoulder, and had had no limitation of motion in any direction.

Of the typical cases the signs and symptoms have been admirably described by Codman[13] (although his classification into three types is open to criticism) and, less fully, by others. Of the larger number of less characteristic and atypical cases the diagnosis is to be made, not by a few clear-cut signs and symptoms, but by: a careful history of the onset and development; an inquiry concerning traumata of the kinds above described; a consideration of the incidence, location, and radiation of the pain, and its behavior at night and on resting the arm; a painstaking inspection and palpation of both shoulder girdles; tests of all the shoulder movements, active and passive; the exclusion of such lesions as arthritis, cervical rib, bone inflammations, true brachial neuritis (extensive brachial neuralgia may be due to subacromial bursitis), and forms of shoulder disability other than bursitis; and, finally, roentgen-ray examination.

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[12] Brickner, W. M., Shoulder Disability (Stiff and Painful Shoulder), Amer. Jour. Surg., 1912, xxvi, 196.

[13] Loc. cit., second article.

A radiograph is of the greatest importance in all cases. When a bursitis has been diagnosed clinically, the picture may show, instead, a localized periostitis, tuberculosis or syphilis of the head of the humerus, a small fracture, or other lesion. *Per contra,* in cases in which the signs and symptoms suggest some other form of shoulder disability the roentgen-ray plate may reveal tell-tale calcareous deposits. A normal radiographic appearance of course does not exclude a bursitis without lime deposit.

6. "EXCISION OF THE BURSA;" OPERATIVE TREATMENT. I shall not here describe the non-operative treatment nor, in detail, the indications for operation. In acute cases, if there are severe and increasing pain and loss of function and a radiograph shows lime formation, open operation affords the promptest relief; indeed, if I may generalize from two cases, it speedily aborts a condition that would otherwise be very prolonged. In less severe acute cases, without evidence of tendon injury, treatment by rest, preferably in bed, with the arm abducted, should be given a full trial.[14] In long-standing cases much can often be done by persistent conservative measures; but none of my cases with lime deposits has been relieved of pain except those operated upon. If the pain and loss of function seriously interfere with sleep and work, if the muscles are undergoing atrophy and, especially, if there is a deposit, operation provides the surest means of early cure. The breaking of bursal adhesions under narcosis is a more uncertain and far more risky procedure for, as Codman[15] reports, it is not without danger to the large vessels, the brachial plexus, the muscles, and, I would add, the bone itself.

The recommendation in text-books to "excise the entire bursa" is evidently based on this advice in the articles of Baer and Painter, each of whom reports cases in which they performed this operation. They both speak of the bursa as "the size of a silver half-dollar" and refer to its apparently easy removal through a five-centimeter incision, by Painter, through "an incision of small extent," by Baer. It is quite clear, therefore, that they had merely excised the subdeltoid portion, which is still rather generally supposed to be a separate sac. Küster[16] had previously shown, and Codman has subsequently emphasized, that this is not so.

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[14] Brickner, A Simple, Easily Regulable Method of Applying Abduction in the Treatment of Shoulder Disability, Medical Record, January 2, 1915.

[15] Loc. cit., second article.

The subacromial is one of the largest bursæ in the body. Above, it is adherent to the under surface of the acromion process and the coraco-acromial ligament, wherefrom it is reflected onto the joint capsule. Below, it is adherent to the inner surface of the deltoid muscle, extending fully one and a half inches distad to the greater tuberosity. Anteriorly and posteriorly, it encircles almost one-half the circumference of the humerus, and is attached by its under surface to the bone, the joint capsule, the biceps sheath and the tendons of the subscapularis and the spinati. Surely the complete removal of this extensive, intimately attached structure would be an imposing task! For an attempt to perform it I can conceive but a single indication—tuberculosis.

The removal of even the subdeltoid portion is, it seems to me, quite unnecessary—theoretically, because a person ought to have as good function with a thickened bursal area as with an absence of that lubricating surface; practically, because, in my experience, there are prompt relief of pain and early restoration of function after the following operation.

OPERATION. The patient is turned partly on his side, and a cushion is placed under the affected shoulder to conveniently expose its outer surface. The forearm and hand, which may be laid across the body, are wrapped in sterile towels or pillowcase so that, if necessary, an assistant can manipulate the extremity.

A two-and-a-half- to three-inch vertical incision is made from the outer border of the acromion process downward over the greater tuberosity, *i. e.*, toward the external condyle (Fig. 4). The exposed deltoid muscle is split in the same line, largely by blunt, partly by sharp dissection. Retraction of the muscle exposes the roof of the bursa. This is drawn up, away from the bone, with two forceps, and freely divided between them, in the line of the muscle incision (Fig. 5). With retractors in the bursa its interior is thus freely exposed where it is usually most affected, viz., over the greater tuberosity (Fig. 6). Adhesive strands or bands are divided with scissors or excised. "Villous" or "papilloma-like" masses, as described by Painter and Codman, if found, are cut away. With curved scissors, concavity toward the humerus, the sac is then explored below (toward the deltoid insertion), anteriorly, posteriorly, and above (under the acromion), and any further adhesions are divided. The bursa is then explored with the finger, the arm being rotated backward, then forward, and pulled down upon, to facilitate this palpation, if necessary. At the site of maximum injury the bursal wall may be more or less thickened. I have not seen it thick enough to suggest the necessity of excising even small areas.

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[16] Ueber Bursitis Subacromialis (Periarthritis Humero-Scapularis), Arch. f. klin. Chir., 1902, lxvii, 1013.

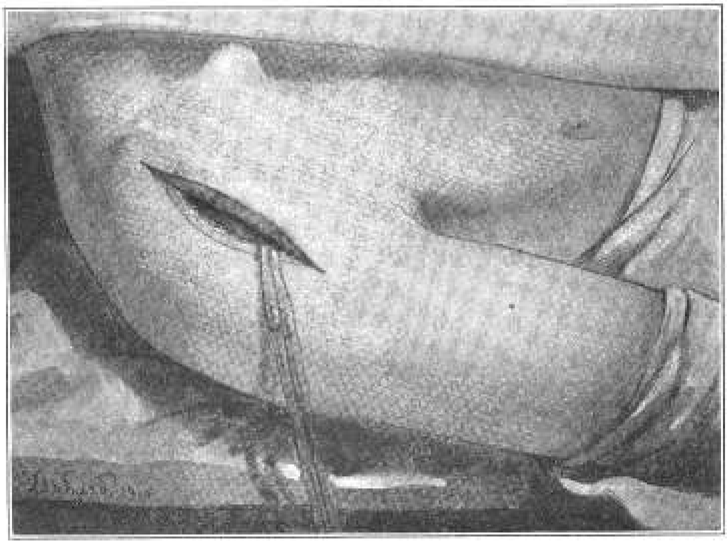

Fig. 4.—The incision. The lateral-supine position of the patient is not indicated.

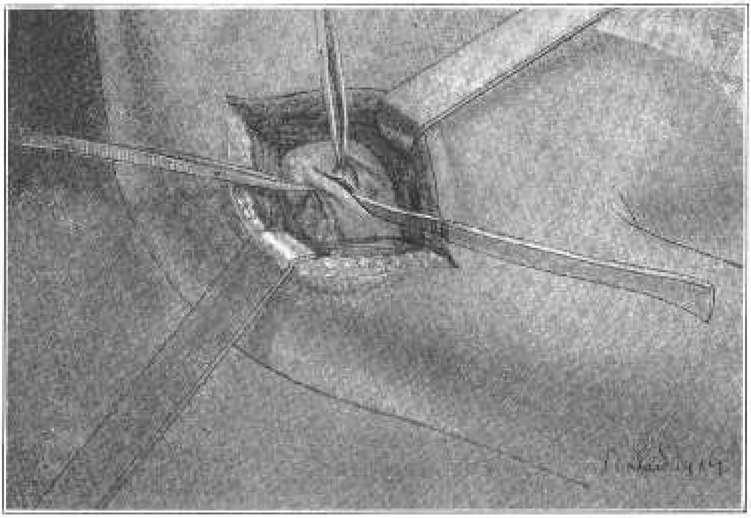

Fig. 5.—The deltoid separated by retractors. The roof of the bursa is drawn up by toothed forceps and divided between them.

The floor of the bursa is now incised, in the same dissection line, over the greater tuberosity and the supraspinatus insertion, and dissected up from the tendon. If a deposit, fluid or solid, is thus found, it is removed with a blunt spoon (Fig. 7). The tendon thus exposed will reveal a superficial injury or a distinct small trans-

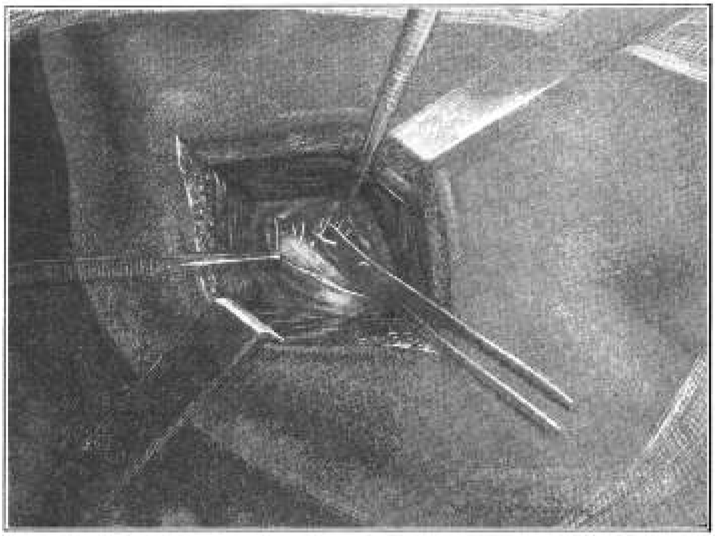

Fig. 6.—The bursa is held open and adhesions are divided.

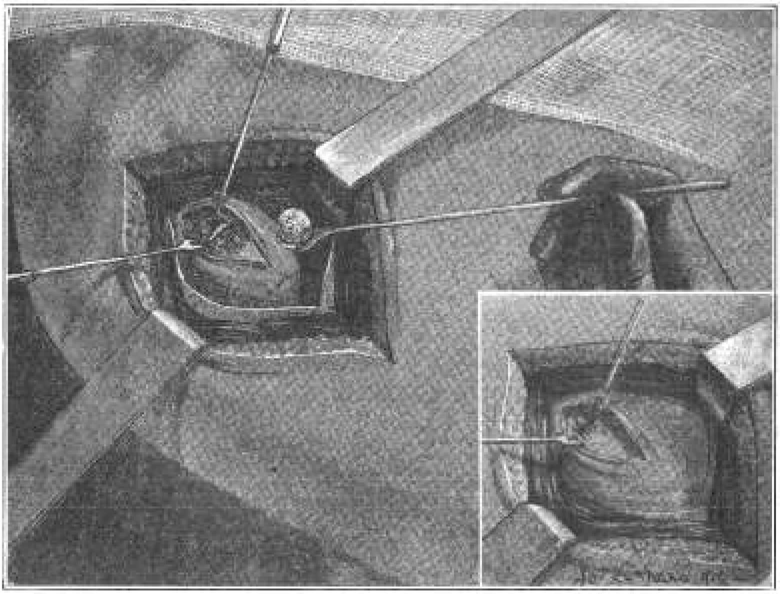

Fig. 7.—The floor of the bursa is incised, dissected up and retracted. An extratendinous deposit is removed with a spoon. The small tear in the tendon is sutured after trimming the edges.

verse tear, within which is more of the solid or cheesy material. The edges of the rent are trimmed with a scalpel to remove adhering granules and frayed fibers. The tendon wound is then closed

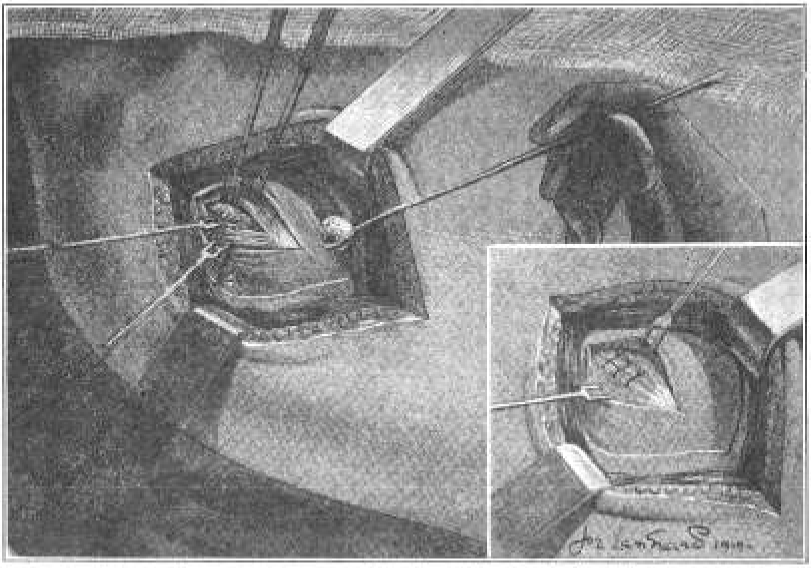

FIG. 8.—The divided floor of the bursa is retracted. The supraspinatus tendon is split and held open and the intratendinous deposit is removed. The split tendon is reunited with chromicized catgut sutures after trimming away the fibers surrounding the lime.

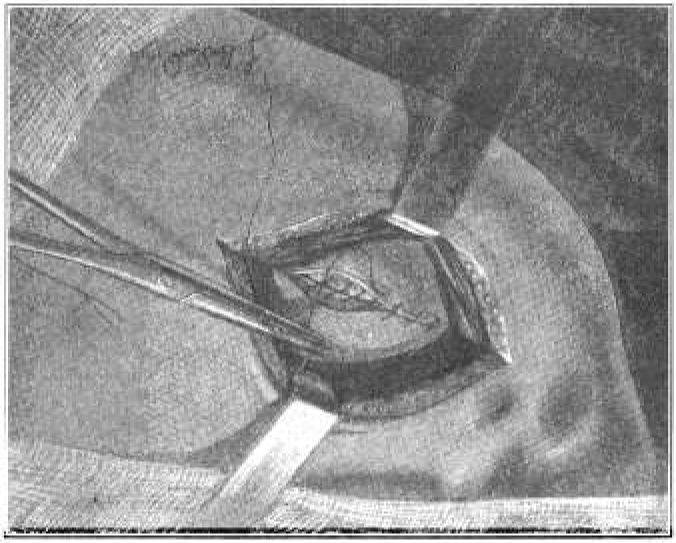

FIG. 9.—Reconstruction of the bursa by suturing its divided floor and its roof.

with a couple of vertically placed chromicized catgut stitches (Fig. 7). If no extratendinous deposit is found, the supraspinatus tendon is opened axially at the point suggested by the roentgenogram, if necessary enlarging upward the incision in the floor of the bursa. The tendon wound is retracted and the deposit is spooned out (Fig. 8). The tissue immediately surrounding the deposit is trimmed away with the granules adhering to it. The tendon is sutured with transverse stitches of chromicized catgut (Fig. 8). If no deposit is found in the supraspinatus the infraspinatus is opened, axially, and the material removed therefrom in the same way.

The above paragraph refers to those cases in which the roentgenogram shows a shadow or shadows. In all cases, however, I think it worth while to examine the tendons for a possible tear, through a small incision in the floor of the bursa.

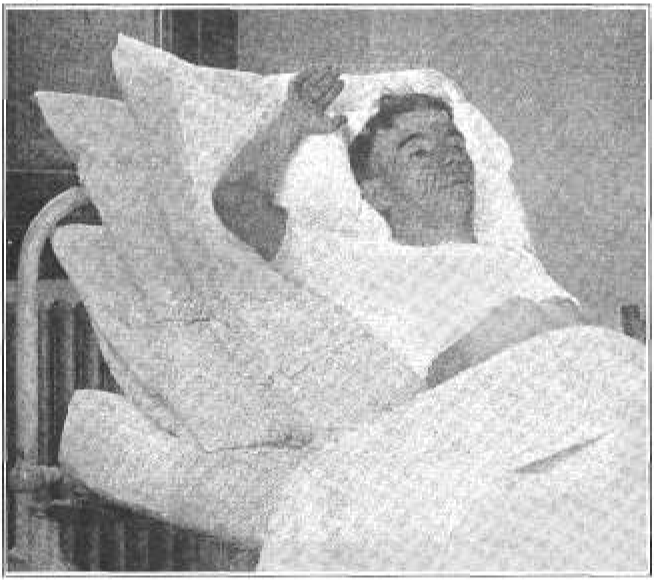

FIG. 10.—The arm is kept in abduction by a light plaster-of-Paris spica.

The incision in the bursal floor is closed with fine catgut sutures. In some cases of very adherent extratendinous deposit, these cut edges of the bursa are so frayed at this site, after it has been dissected up, that it cannot be entirely approximated over the tuberosity.

A thin layer of vaseline is spread over the lining of the sac with the gloved finger or a smooth instrument. No small lump of the lubricant is left in, lest, by encystment, it might cause adhesions. In spite of this theoretical objection to the vaseline, I have found that it behaves well in these cases, and I believe that it probably prevents the immediate reformation of the adhesions. The roof of the bursa is sutured completely with catgut (Fig. 9). Codman thinks it advisable to leave both layers of the sac unsutured so that fluids may drain through. I see no advantage in this practice; it has the perhaps theoretical objection that through gaps in the bursa adjacent structures may become adherent to the opposite wall.

The deltoid muscle is allowed to fall together. I usually insert a few catgut stitches. The skin wound is closed without drainage. The arm is dressed in abduction of about 120 degrees, in a light plaster-of-Paris spica (Fig. 10).

The abduction is continued until the first dressing—eight to ten days. Painter sees no advantage in the primary abduction and Codman abandoned it. I think it quite important. It relaxes the sutured supraspinatus; it relaxes the bursal walls and puts them in the position of maximum separation; it stretches the contracted periarticular structures (muscles chiefly), and assures at once a certain amount of abduction capacity, thus, I believe, reducing the period of after-treatment. It is a position by no means insupportable, and though some patients find it irksome, their discomfort is a small price to pay for the service it renders.

After the cast is removed the healed wound needs but a bit of gauze and adhesive plaster or collodion; and the patient is free to move his arm about. He is instructed to move it but little and gently at first, to rest it in a sling when sore or fatigued, and at night to abduct it as much as he comfortably can on pillows, or with a bandage carried from the wrist to the head of the bed. In the third week after the operation more active movements are instituted, if necessary. The length of time needed for full restoration of shoulder function depends upon how much and how long it had been previously interfered with. In cases of moderate disability, cure may be complete, or nearly so, within a month. In more severe cases, it will take two or three months to effect restoration of *full* mobility, by means of light Indian-club exercises, etc. Long after abduction is fully restored, there is apt to persist some limitation of internal rotation (inability to quite touch the opposite scapula across the back).